CLAIMS

What Is Claimed:

1 1.   A method for simulating a multi-dimensional space, comprising:

2   generating a sequence of pseudo-random numbers according to a

3 prescribed quasi-Monte Carlo model; and

4   mapping each pseudo-random number R of the sequence of

5 random numbers into multiple variables of unique values for the multi-

6 dimensional space, the multi-dimensional space including D dimensions,

7 where D is a number.

1 2.   The method of claim 1, further comprising assigning the unique values to

2 each dimension based upon a prescribed index.

1 3.   The method of claim 1, further comprising sampling the multiple variables

2 of the multi-dimensional space and statistically analyzing the sampled

3 multiple variables according to a prescribed error analysis.

1 4.   The method of claim 1, further comprising sampling the multiple variables

2 of the multi-dimensional space and performing numerical integrations

3 upon the sampled multiple variables.

1 5.   The method of claim 1, wherein each pseudo-random number R

2 generated by the prescribed quasi-Monte Carlo model includes a floating

3 point number having a value between 0.0 and 1.0, further wherein each

4 dimension is characterized by a unique value based upon an index, the

5 index equal to a total combinations of dimensional value points TC times a

6 respective pseudo-random number R.

6. The method of claim 1, wherein each of the multiple variables of the multi-dimensional space represents a corresponding D dimension value and wherein each dimension is characterized by a minimum and a maximum value, further wherein each dimension is characterized by a prescribed resolution S.

7. The method of claim 6, wherein the D dimension values are further characterized by a first dimension D0 that includes minimum and maximum values defined as D0.min and D0.max, respectively, a second dimension D1 that includes minimum and maximum values defined as D1.min and D1.max, etceteras, up to a Dth dimension.

8. The method of claim 6, further comprising selecting a value of S according to a desired accuracy of a final simulation value, wherein the value of S defines a grid for use in conjunction with the mapping of the pseudo-random numbers into the multiple variables of the multi-dimensional space.

9. The method of claim 8, wherein selecting the value of S includes deriving the value of S such that a ratio r, as defined by $r = s^D/P^N$, is not factorable by one of the following selected from the group consisting of base P and the number of dimensions D, and where N is the number of pseudo-random numbers and r is a prescribed prime number.

10. A method for simulating a multi-dimensional space, comprising:

generating a sequence of pseudo-random numbers according to a prescribed quasi-Monte Carlo model;

mapping each pseudo-random number R of the sequence of random numbers into multiple variables of unique values for the multi-dimensional space, the multi-dimensional space including D dimensions, where D is a number, wherein each of the multiple variables of the multi-dimensional space represents a corresponding D dimension value and wherein each dimension is characterized by a minimum and a maximum value, the D dimension values further being characterized by a first dimension D0 that includes minimum and maximum values defined as D0.min and D0.max, respectively, a second dimension D1 that includes minimum and maximum values defined as D1.min and D1.max, etceteras, up to a Dth dimension, further wherein each dimension is characterized by a prescribed resolution S; and

selecting a value of S according to a desired accuracy of a final simulation value, wherein the value of S defines a grid for use in conjunction with the mapping of the pseudo-random numbers into the multiple variables of the multi-dimensional space, wherein selecting the value of S includes deriving the value of S such that a ratio r, as defined by $r = s^D/P^N$, is not factorable by one of the following selected from the group consisting of base P and the number of dimensions D, and where N is the number of pseudo-random numbers and r is a prescribed prime number.

1 11. A method for simulating trace impedance of a printed circuit board
2   characterized by at least three dimensions of a multi-dimensional space,
3   said method comprising:
4   generating a sequence of pseudo-random numbers according to a
5   prescribed quasi-Monte Carlo model; and
6   mapping each pseudo-random number R of the sequence of
7   random numbers into multiple variables of unique values for the multi-
8   dimensional space, the multi-dimensional space including D dimensions,
9   where D is a number.

1 12. The method of claim 11, further comprising assigning the unique values to
2   each dimension based upon a prescribed index.

1 13. The method of claim 11, further comprising sampling the multiple variables
2   of the multi-dimensional space and statistically analyzing the sampled
3   multiple variables according to a prescribed error analysis.

1 14. The method of claim 11, further comprising sampling the multiple variables
2   of the multi-dimensional space and performing numerical integrations
3   upon the sampled multiple variables.

1 15. The method of claim 11, wherein each pseudo-random number R
2   generated by the prescribed quasi-Monte Carlo model includes a floating
3   point number having a value between 0.0 and 1.0, further wherein each
4   dimension is characterized by a unique value based upon an index, the
5   index equal to a total combinations of dimensional value points TC times a
6   respective pseudo-random number R.

1   16.   The method of claim 11, wherein each of the multiple variables of the

2   multi-dimensional space represents a corresponding D dimension value

3   and wherein each dimension is characterized by a minimum and a

4   maximum value, further wherein each dimension is characterized by a

5   prescribed resolution S.

1   17.   The method of claim 16, wherein the D dimension values are further

2   characterized by a first dimension D0 that includes minimum and

3   maximum values defined as D0.min and D0.max, respectively, a second

4   dimension D1 that includes minimum and maximum values defined as

5   D1.min and D1.max, etceteras, up to a Dth dimension.

1   18.   The method of claim 16, further comprising selecting a value of S

2   according to a desired accuracy of a final simulation value, wherein the

3   value of S defines a grid for use in conjunction with the mapping of the

4   pseudo-random numbers into the multiple variables of the multi-

5   dimensional space.

1   19.   The method of claim 18, wherein selecting the value of S includes deriving

2   the value of S such that a ratio r, as defined by $r = s^D/P^N$, is not factorable

3   by one of the following selected from the group consisting of base P and

4   the number of dimensions D, and where N is the number of pseudo-

5   random numbers and r is a prescribed prime number.

1   20.   Apparatus for simulating trace impedance of a printed circuit board, the

2   printed circuit board characterized by at least three dimensions of a multi-

3   dimensional space, said apparatus comprising:

4   a random number generator for generating a sequence of pseudo-

5   random numbers according to a prescribed quasi-Monte Carlo model;

6   a mapping processor for mapping each pseudo-random number R

7   of the sequence of random numbers into multiple variables of unique

8   values for the multi-dimensional space, the multi-dimensional space

9   including D dimensions, where D is a number, wherein each of the

10   multiple variables of the multi-dimensional space represents a

11   corresponding D dimension value and wherein each dimension is

12   characterized by a minimum and a maximum value, the D dimension

13   values further being characterized by a first dimension D0 that includes

14   minimum and maximum values defined as D0.min and D0.max,

15   respectively, a second dimension D1 that includes minimum and

16   maximum values defined as D1.min and D1.max, etceteras, up to a Dth

17   dimension, further wherein each dimension is characterized by a

18   prescribed resolution S; and

19   a value selector for selecting a value of S according to a desired

20   accuracy of a final simulation value, wherein the value of S defines a grid

21   for use in conjunction with the mapping of the pseudo-random numbers

22   into the multiple variables of the multi-dimensional space, wherein

23   selecting the value of S includes deriving the value of S such that a ratio r,

24   as defined by $r = s^D/P^N$, is not factorable by one of the following selected

25   from the group consisting of base P and the number of dimensions D, and

26   where N is the number of pseudo-random numbers and r is a prescribed

27   prime number.

21. A method of manufacturing a printed circuit board comprising:

characterizing the printed circuit board by at least three dimensions of a multi-dimensional space; and

manufacturing the printed circuit board in accordance with a simulated trace impedance, the simulated trace impedance obtained by:

generating a sequence of pseudo-random numbers according to a prescribed quasi-Monte Carlo model;

mapping each pseudo-random number R of the sequence of random numbers into multiple variables of unique values for the multi-dimensional space, the multi-dimensional space including D dimensions, where D is a number, wherein each of the multiple variables of the multi-dimensional space represents a corresponding D dimension value and wherein each dimension is characterized by a minimum and a maximum value, the D dimension values further being characterized by a first dimension D0 that includes minimum and maximum values defined as D0.min and D0.max, respectively, a second dimension D1 that includes minimum and maximum values defined as D1.min and D1.max, etceteras, up to a Dth dimension, further wherein each dimension is characterized by a prescribed resolution S; and

selecting a value of S according to a desired accuracy of a final simulation value, wherein the value of S defines a grid for use in conjunction with the mapping of the pseudo-random numbers into the multiple variables of the multi-dimensional space, wherein selecting the value of S includes deriving the value of S such that a ratio r, as defined by $r = s^D/P^N$, is not factorable by one of the following selected from the group consisting of base P and the number of dimensions D, and where N is the number of pseudo-random numbers and r is a prescribed prime number.

1 22. A computer system, comprising:

2   a printed circuit board manufactured in accordance with a simulated

3 trace impedance, said printed circuit board including impedance traces

4 that characterize at least three dimensions of a multi-dimensional space of

5 said printed circuit board , wherein said impedance traces include trace

6 impedances obtained by:

7   generating a sequence of pseudo-random numbers

8   according to a prescribed quasi-Monte Carlo model;

9   mapping each pseudo-random number R of the sequence of

10   random numbers into multiple variables of unique values for the

11   multi-dimensional space, the multi-dimensional space including D

12   dimensions, where D is a number, wherein each of the multiple

13   variables of the multi-dimensional space represents a

14   corresponding D dimension value and wherein each dimension is

15   characterized by a minimum and a maximum value, the D

16   dimension values further being characterized by a first dimension

17   D0 that includes minimum and maximum values defined as D0.min

18   and D0.max, respectively, a second dimension D1 that includes

19   minimum and maximum values defined as D1.min and D1.max,

20   etceteras, up to a Dth dimension, further wherein each dimension is

21   characterized by a prescribed resolution S; and

22   selecting a value of S according to a desired accuracy of a

23   final simulation value, wherein the value of S defines a grid for use

24   in conjunction with the mapping of the pseudo-random numbers

25   into the multiple variables of the multi-dimensional space, wherein

26   selecting the value of S includes deriving the value of S such that a

27   ratio r, as defined by $r = s^D/P^N$, is not factorable by one of the

28   following selected from the group consisting of base P and the

29   number of dimensions D, and where N is the number of pseudo-

30   random numbers and r is a prescribed prime number.